

***Libellago orri* sp. nov. from northern Borneo (Odonata: Chlorocyphidae)**

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ABSTRACT

Libellago orri sp. nov. (holotype ♂: Borneo, Sarawak, Bahagian Bintulu, Samarakan, Sg. Gagak, 06 iii 2006, to be deposited in BMNH) from Malaysian Borneo is described from the male sex and compared with *L. hyalina*, which co-occurs at the same sites. Females of the two species cannot be reliably separated at present.

INTRODUCTION

The Chlorocyphidae are well represented on the island of Borneo; Orr (2003) lists 20 species (plus one probable synonym), two of which – *Rhinocypha viola* Orr, 2002 and *Sundacypha striata* Orr, 1999 – were described within the last decade. Seven species of *Libellago* Selys, 1840 have previously been recorded from the island.

In March 2006 RD was granted permission to collect Odonata within the Planted Forest Zone (PFZ) in Bahagian Bintulu, Sarawak, Malaysian Borneo – a large area of Acacia plantations managed by Grand Perfect Sdn Bhd (GP). Within the PFZ there are several protected areas. Collecting was carried out in three of these areas: Bukit Sarang, an area of secondary alluvial and mixed swamp forest surrounding two small limestone hills, currently a Conservation Area, and a proposed National Park (ca 150 km²); the Sungai (= Sg.) Philip at Samarakan, a stream in the ‘Glen Forest’ – a corridor of old secondary lowland mixed dipterocarp forest protected as a Recreational Forest by GP; and Binyo Penyilam, a Conservation Area consisting of a large area of secondary peat swamp forest. Collecting was also carried out at the Sg. Gagak, a stream similar to and close to the Sg. Philip, but in an Acacia plantation.

A previously undescribed *Libellago* species, allied to *L. hyalina* (Selys, 1859) and occurring syntopically with that species at most sites, was collected at all of the above mentioned locations. This species, described here as *L. orri* sp. nov., is apparently confined to lowland forest habitats in Bahagian Bintulu. It is closely related to *L. hyalina*, but males differ in size, proportions, coloration and markings; females of the two species are at present inseparable. The new species was compared with specimens of *L. hyalina* from locations across Sarawak and from mainland south-east Asia.

All specimens were examined using stereomicroscopes. Measurements were made with the aid of a measuring eyepiece calibrated to a known scale. Terminology used here follows that in Watson & O’Farrell (1991).

Libellago orri sp. nov.

(Figs 1, 2a, 3a, b, Plate II)

Etymology

This species is named in honour of Albert George Orr, author of 'Dragonflies of Borneo', and our friend and collaborator. Bert's fascination with, and love of, the Chlorocyphidae is well known. It was with his encouragement that RD began to visit Sarawak, leading eventually to the discovery of this species.

Specimens examined

Holotype ♂: Borneo, (East Malaysia), Sarawak, Bahagian Bintulu, Samarakan, Sg. Gagak, 06 iii 2006, leg. RD, to be deposited in BMNH (London). — Paratypes, a total of 27 ♂, all from Sarawak, Bahagian Bintulu: Bukit Sarang, all at small streams and pools in secondary freshwater swamp forest, 1 ♂, 01 iii 2006, leg. RD; 2 ♂, 02 iii 2006, leg. RD; 1 ♂, 02 iii 2006, leg. Supiandi; 1 ♂, 03 iii 2006, leg. Lim Chan Koon; Samarakan – 2 ♂, Sg. Philip, 05 iii 2006, leg. RD; 2 ♂, Sg. Gagak, 06 iii 2006, leg. Chin Sing Yun; 9 ♂, Sg. Gagak, 06 iii 2006, leg. RD; Binyo Penyilam, all at the Sg. Penyilam; 1 ♂, 08 iii 2006, leg. RD; 1 ♂, 09 iii 2006, leg. Azizan Juhin; 2 ♂, 09 iii 2006, leg. RD; 1 ♂, 10 iii 2006, leg. Azizan Juhin; 1 ♂, 10 iii 2006, leg. RD; 3 ♂, 11 iii 2006, leg. RD. Paratypes are placed in the following collections: BMNH (London), RMNH (Leiden), Kanagawa Prefectural Museum of Natural History (Odawara), coll. M. Hämäläinen, coll. R.A. Dow and coll. A.G. Orr. — Other specimens: *L. hyalina* for comparison, a total of 44 ♂ and 24 ♀: 22 ♂, 5 ♀ from locations across Sarawak in coll. Dow; 22 ♂ and 19 ♀ from mainland south-east Asia in coll. Hämäläinen.

Diagnosis

A hyaline winged *Libellago* species lacking a flattened anterior facet in the rhinarium (ante- and postclypeus). Male abdomen with pale cerulean dorsal markings (Plate IIa); unlike males of *L. hyalina*, the markings are not reddish in the teneral stage and the abdomen does not acquire a metallic sheen with maturity.

Description of holotype male

Head: Labium with postmentum, basal half of prementum and basal one quarter of palps pale yellow, the remainder shining black. Base of mandibles with large yellow marks (Fig. 1a). Labrum and anterior surface of rhinarium (ante- and postclypeus) shining black, as is the ridge separating the anterior and posterior surfaces of rhinarium. Posterior surface of rhinarium matt black with baso-lateral yellow marks and a smaller and fainter pair of dorso-lateral yellow marks. Rhinarium without a flattened anterior facet. Genae with broad yellow marks, these markings extending upwards in a narrow line along the eye margin as far as the end of the second antennae segment (pedicel). The visible part of pedicel largely yellow. The flagellum of antennae black. Frons and vertex matt black with yellow markings (Fig. 1b).

Thorax: Prothorax black with yellow markings as follows (Figs 1c, d). A broad horizontal band occupying much of the anterior part of the anterior lobe and small lateral marks on the posterior part of the anterior lobe. Large subtriangular lateral

markings on the median lobe and a pair of very small spots dorsally. A transverse band across the posterior lobe, extended mid-dorsally for a short distance both anteriorly and posteriorly. Synthorax black with yellow stripes and markings as follows (Fig. 1e). Antehumeral stripe narrow, extending for about $\frac{1}{3}$ of the length of mesepisternum, then interrupted and continuing as a shorter and very narrow stripe in the posterior half of mesepisternum. A long, narrow curved stripe running below the humeral suture on mesepimeron. Small, narrow transverse marks just below the antealar crest in metepisternum and mesepimeron. Metepisternum largely occupied by a complicated hooked yellow marking as in Figure 1e. Metepimeron with broad yellow band, extended vertically at its upper end. A faint brown, subtriangular marking at the lower end immediately adjacent to the posterior coxa. Mesinfraepisternum with a rectangular yellow mark in its lower posterior corner, a smaller pale brown mark in the corresponding part of metinfraepisternum, contiguous with the brown marking on metepimeron. Ventral side of synthorax largely black, with the poststernum yellowish brown. Coxae largely black, with yellow or pale brown stripes on posterior side. Trochanters black with obscure brownish markings. Femora and tibiae black. — Wings (Fig. 2a) all hyaline but with a faint brownish tint. Fw with 7-8 Ax and 12 Px; Hw correspondingly with 8 and 11. Arculus in line with Ax 2 or slightly distal to it. Quadrilateral crossed once, ending at Ax 5 or proximal to it (right Fw). Subquadrilateral of 3 cells, strongly angulated where the arculus meets it. Three (left) or four (right) crossveins between subcosta and R+M proximal to the subnodus. 1A arises at Ax 1 or just proximal to it, Ac just distal to or in line with Ax 1. 1A meets wing margin variably at or between Px 5 and 6. CuP in Fw meets wing margin between Px 7 and 8, in Hw between Px 6 and 7. MA meets wing margin at Px 11 in Fw and at or distal to Px 10 in Hw. R_4 arises around Ax 3, meets wing margin roughly in line or just proximal to proximal end of Pterostigma. IR_3 arises at Ax 3 or distal to it, meets wing margin approximately in line with distal end of Pt. R_3 arising in line with or distal to Px 2, meets wing margin distal to Pt. Two cell rows between R_4 and Rspl for most of length after first cell, 5-7 cells at wing margin. Pt very dark brown, covering two entire underlying cells (one in right Fw) and between $\frac{1}{2}$ and $\frac{2}{3}$ of the ones at either end.

Abdomen: Short and moderately broad, widest at S3-4, somewhat dorso-ventrally flattened (Figs 3a, b). Black with pale cerulean markings as noted below. S1 laterally with a broad marking occupying the distal $\frac{2}{3}$ and extending dorsally for a short distance in its distal third. Dorsally with a small apical middorsal spot close to the posterior carina, aligned with a tiny spot on the carina itself. S2 laterally with a roughly oval longitudinal central mark and a larger, transverse mark at the distal



Figure 1: Head and thorax of *Libellago orri* sp. nov. — (a) head, lateral view; (b) head, dorsal view; (c) prothorax, lateral view; (d) prothorax, dorsal view; (e) synthorax, lateral view.

end, extending onto the dorsal surface for a short distance. Dorsally with a narrow middorsal stripe, expanded at around the middle of the segment, narrowing and expanding again in the apical quarter before narrowing to meet the posterior carina, tapering to the front and not quite reaching the base of the segment. S3 laterally with an elongate longitudinal mark in the anterior two-thirds, extended downwards at its apical end, and a smaller, roughly oval, transverse mark at the distal end, extending a short distance onto the dorsal surface. Dorsally with a middorsal stripe, slightly wider than that on S2, somewhat irregular and not quite reaching the posterior carina. S4-8 dorsally with broad pale cerulean markings, and occupying most of the dorsal surface of the segments (Fig. 3b). S8 also with a pair of tiny, faint apical brownish yellow marks. S4 laterally with a small faint anterior mark and a small anterior mark just in front of the posterior carina joined to the dorsal mark by a narrow stem. S5-8 laterally with a very faint dark brown anterior mark, small and obscurely shaped. S9 black with a very faint pale central middorsal marking. S10 entirely black. Ventrally the abdomen is largely black, with narrow yellowish lines at the boundaries between segments and dark brown areas bordering the midventral sternum on the middle segments. Anal appendages black, typical for the genus. Penis structure is quite similar to that of other *Libellago* species, e.g. *L. hyalina*. **Measurements [mm]:** Fw 18.2, Hw 17.9, abdomen 12.4 (excl. appendages), superior appendages 0.9.

Variation in paratype males

There is considerable variation in the colour of the pale markings, and the extent of some of them, amongst the paratypes. Part of this variation is related to age. In three teneral males examined the pale markings are bright, pale yellow, the pale markings on the labium are reduced, the transverse band on the posterior lobe of the thorax is reduced to pale marks in the corners and on the mid-dorsal line, there are lateral markings on S4-8, similar to those on S3 of the holotype, and with the posterior mark variably extended onto the dorsum, but with the anterior marking larger and diffuse. The dorsal marking on S9 is larger and clearer than in the holotype.

With age the yellow coloration changes to a pale dull orange-brown colour and then to the pale cerulean colour seen in the holotype, with greenish intermediates. On the abdomen these colour changes begin on the anterior segments first. The pale markings on the labium appear to become more extensive with age, but perhaps this character also varies independently of age. The transverse band on the posterior lobe

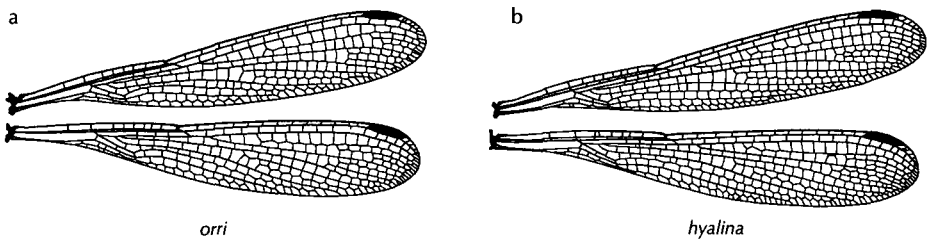


Figure 2: Wings of two *Libellago* species in comparison — (a) *L. orri* sp. nov.; (b) syntopic *L. hyalina*.

of the prothorax varies between the reduced condition seen in the teneral specimens to the complete band seen in the holotype. The lateral markings on S4-8 fade with age, starting at S8. The posterior markings disappear rapidly, but the anterior ones are present as faint brown patches on many specimens, becoming fainter from S4 to S8 and often only easily visible on S4, if present at all. The dorsal mark on S9 fades with age.

The posterior part of the antehumeral stripe is often absent or reduced to a faint spot, sometimes a faint spot is visible on one side but not on the other. In the three teneral paratypes, one has antehumeral stripes as in the holotype, another has no posterior part of the stripe and the third has the posterior part present only on the left-hand side as a faint spot, suggesting that variation in this character is independent of age. The large marking on the metepisternum exhibits little variation, but in some individuals one or more of the hooked extensions is interrupted, leaving a spot isolated from the main marking; this variation appears to be independent of age.

The small apical middorsal markings on S1, present in the holotype, are absent in many of the paratypes. The dorsal marks on S2-3 exhibit apparently age independent variation. In many of the paratypes both are very narrow, and almost straight sided, with no lateral expansions. The S2 mark is often present only on the posterior three-quarters or two-thirds of the segment. In a few specimens the S3 marking is broadly expanded in the central third of the segment, sometimes (as in Fig. 3b) the lateral parts of this marking are also expanded forwards to create a trilobed marking.

The dorsal markings on S8 are variable in their apical half; in some individuals they extend back nearly to the posterior carina, in others they barely reach into the apical half. The small apical markings seen in the holotype may be absent, or larger and are sometimes joined to the larger mark. Again, variation here appears to be age independent.

The wings, especially the hind wings, are tinted with brown to different degrees, varying between barely tinted to heavily tinted. The wings of the teneral material examined are barely tinted, but the tint is variably developed in older specimens, suggesting that age is not the only factor in its development. Wings with 6-8 Ax, 10-13 Px in the Fw and 8-13 in the Hw.

Measurements [mm]: Fw 17.1-18.7, Hw 16.7-18.4, abdomen 11.8-12.9 (excl. appendages), superior appendages 0.8-0.9.

Females

Separation of females of *L. hyalina* and *L. orri* is problematic. No interaction was observed between *L. orri* males and any females, however very little interaction was observed between *L. hyalina* males and females, even at the Sg. Sarang at Bukit Sarang, where *L. hyalina* was exceptionally abundant when collecting was conducted. At the Sg. Gagak, where no males of *L. hyalina* were collected or observed, a number of females were collected and, given the apparent absence of male *L. hyalina*, these appear likely to be *L. orri*. In life the pale markings of these females, and some females from other locations where both species were found, were distinctly greenish (Plate IIB), whereas in supposed and confirmed *L. hyalina* females from various locations in Sarawak the pale markings are yellow without any green coloration. However no reliable differences have been detected in the shape or size of the markings, or in structure, of these females, and in preserved specimens the coloration is the same in all. It is possible that all females collected were actually *L. hyalina*, and that the female of *L. orri* remains unknown; the resolution of this issue awaits the collection of copulating pairs of *L. orri*.

DISCUSSION

Libellago orri is the eighth species of *Libellago* to be found on Borneo, and the fifth to be recorded from Sarawak. It belongs to that group of *Libellago* in which the rhinarium is entirely lacking a flattened anterior facet between the ante- and post-clypeus (Lieftinck 1950: 632 [footnote]; Hämäläinen 2002). Of the species known to occur in Sarawak, only *L. semiopaca* (Selys, 1873) possesses such an anterior facet. The new species is clearly differentiated from all other known *Libellago* species by its coloration and markings. In particular it is separated by all *Libellago* species known to occur in Sarawak, except for *L. hyalina*, by the absence of dark markings on the distal portion of the Fw.

Males of *L. orri* and *L. hyalina* are easily separated by the coloration and markings of the male abdomen; *L. orri* has no bright red coloration on its abdomen at any stage, as found in immature *L. hyalina* males, nor does it ever develop an entirely dark abdomen with purplish metallic reflections (Fig. 3c), as found in mature *L. hyalina* males. On the other hand there are no marked differences in the colour pattern of male thorax; the complicated hooked yellow stripe on metepisternum is quite similar in *L. hyalina* and *L. orri*.

Moreover, *L. hyalina* syntopic with *L. orri* are larger than *L. orri* (Figs 3b, c), with an average Hw length of 18.6 mm in *hyalina* compared with 17.6 mm in *orri* and an average abdomen length (excl. appendages) of 13.0 mm in *L. hyalina* compared with 12.3 mm in *L. orri*. There are also some differences in the relative proportions of the two species. In *L. hyalina* from Bahagian Bintulu the ratio of the distance from wing base to nodus, to the distance from nodus to Pt is 0.78 in the Fw and 0.88 in the Hw, in *L. orri* the corresponding ratios are 0.85 and 0.96 respectively (Figs 2a, b). The problem of differentiating females of *L. hyalina* and *L. orri* was discussed above, at present no character that reliably separates the females of the two species is known. It may be that females of *L. orri* and *L. hyalina* are not distinguishable unless taken in copula, the resolution of this issue awaits the capture of tandem pairs of *L. orri*.

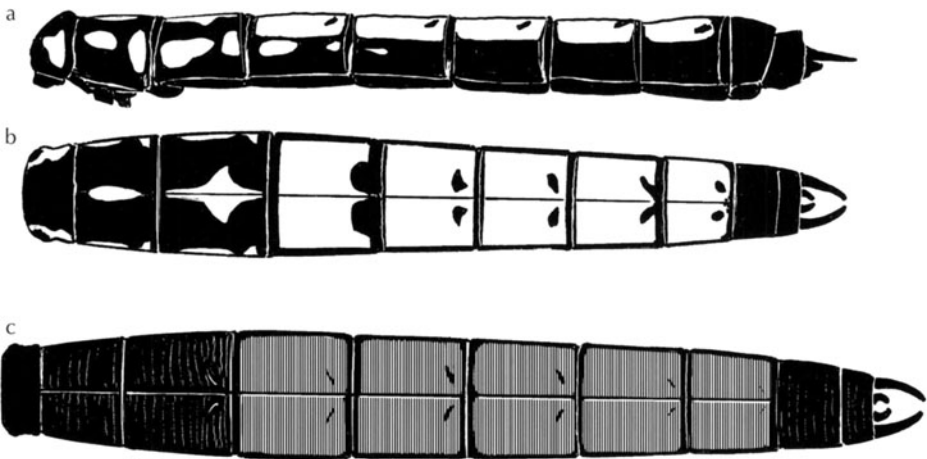


Figure 3: Abdomen of two *Libellago* species in comparison — (a) *L. orri*, lateral view; (b) same, dorsal view; (c) syntopic *L. hyalina*, dorsal view.

It should be noted that populations of *L. hyalina* from different areas of Sarawak vary quite considerably in size. Populations from Bahagian Kuching and Bahagian Samarahan in west Sarawak are smaller than those from Bahagian Bintulu, approaching *L. orri* in size. Populations of *L. hyalina* from Bahagian Miri in north-east Sarawak are larger than those from the west but smaller than those from Bahagian Bintulu.

We have very little information about the biology and ecology of *L. orri*. All of the known locations are in lowland forest (either secondary or acacia plantation). Its habitat requirements appear to be very similar to those of *L. hyalina*, with which it occurs syntopically at all locations except for the Sg. Gagak, which runs through an acacia plantation. The apparent absence of *L. hyalina* from the Sg. Gagak, where *L. orri* was very abundant when collecting was carried out, suggests that *L. orri* may be more tolerant of disturbance than *L. hyalina*. The preferred habitat of both species is clearly sluggish forest streams with a bed of sediment, although both are sometimes found on pools in swamp forest, with reproductive activity probably requiring some water flow. However the nature of the surrounding forest, the depth of the water and its pH, vary considerably between the different locations. No agonistic displays or courtship behaviour were observed from *L. orri* males and no interaction was observed between *L. hyalina* and *L. orri*.

The presence of a forest species with an apparently limited distribution such as *L. orri* on a highly disturbed plantation stream such as the Sg. Gagak is noteworthy. The facts that the species is present on the less disturbed Sg. Philip not far away and that, unusually in plantations in Sarawak, the undergrowth has been allowed to grow in GP's acacia plantations, are both likely to be significant in this regard. To the author's knowledge GP is the only company managing plantations in Sarawak that maintains a conservation office, and the conservation efforts of the company are the best in any plantations in Sarawak, due to the hard work and enthusiasm of the small group of staff employed in this regard. GP should be encouraged to maintain and improve upon their current conservation practices.

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